

TECHNOLOGY DEVELOPMENT PROGRAM AREA

OVERVIEW

The mission of the Technology Development Program in the Environmental Management Office of Science and Technology is to provide new or improved technologies to reduce risks and the cost of cleanup. In some cases, there are no known methods by which to clean up contamination, and the methods that do exist are often expensive or ineffective. To this end, an aggressive national research and development program is conducted that currently addresses five major problem (or focus) areas identified by the Environmental Management Program:

- High Level Waste Tank Remediation: addresses the large number of storage tanks containing over 100 million gallons of radioactive waste.
- Mixed Waste Characterization, Treatment, and Disposal: addresses treatment and disposal of hazardous, low-level and transuranic radioactivity contamination.
- Landfill Stabilization: addresses the migration and remediation challenges posed by DOE landfills.
- Contaminant Plumes Containment and Remediation: addresses uncontained hazardous and radioactive contaminants in soil and groundwater.
- Decontamination and Decommissioning: addresses the need to transition, decommission, deactivate, and dispose of aging and contaminated DOE weapons complex facilities.

Crosscutting programs support all Focus Areas:

- Efficient Separations: develops technologies to extract radionuclides to reduce waste volume, saving disposition costs.
- Characterization, Monitoring, and Sensors: develops systems to accurately characterize, monitor, and analyze wastes.
- Robotics: reduces worker risk by using remotely controlled robotic systems.
- Technology Integration: involves critical external entities (sites, users, public, tribes, regulators, private industry, universities) in ensuring that innovative technical solutions are acceptable and commercially available.
- Industry Programs: ensures private industry and university participation in developing and implementing innovative technologies through Program Research and Development Agreements and Research Opportunity Announcements.

The Maryland/D.C. Headquarters Office provides policy guidance and programmatic integration and oversight. Technical management of the Focus Areas has been delegated to specific Operations Offices, as indicated in Figure _____. Further descriptions of Focus Area technologies and the technical needs they fulfill are provided later in this section. In addition to the above efforts, the Office Technology Integration involves critical external entities (sites, users, public, tribes, regulators, private industry, universities) in ensuring that innovative technical solutions are acceptable and commercially available.

[Insert national map with FA lead sites identified]

OBJECTIVES

Technology Development Program objectives are associated with the program goal of focusing the technology development activities on DOE's major environmental management issues, while involving the best talent in DOE and national (public and private) science and engineering communities. These objectives are to:

- Reduce cleanup costs
- Reduce risks
- Solve cleanup problems that currently have no solutions

The Technology Development Program incorporates the excellence of national (public and private) science and engineering communities by forming partnerships with industry, academia, and other government agencies. The Program leverages its resources with all partners to satisfy the DOE need for reducing costs and risk. Only those with the best skills, technology, and ability to manage costs are selected as technology development partners.

DECISION TOOLS

RISK

As a customer and market-oriented effort, the Technology Development Program is responsive to health and environmental risk-reduction needs determined by the DOE sites. Within the Program, risk is minimized through such means as: systematically evaluating technologies as they advance through successive development decision points; relying on external, qualified, and independent peer review to evaluate programs and projects; integrating activities across EM; and fostering continual involvement of regulators and stakeholders (national and local) in order to enhance acceptance of innovative technologies and systems. The Office of Science and Risk Management has the mission to ...

COMPLIANCE

Environmental regulatory requirements provide a temporal framework for EM technology development activities. New technologies must be available well in advance of Federal Facility Agreement milestones and CERCLA/RCRA Records of Decision to provide maximum assistance for negotiations with regard to remedy selection. The schedules for final negotiation of these RODs in part define DOE's windows of opportunity for introducing critical technology solutions, because new technologies can be added for consideration in existing RODs.

COST

Within the Office of Environmental Management, the Technology Development Program has pioneered the application of project control methodologies, including earned-value analysis, as management decision tools. Cost-related initiatives include application of cost-benefit analysis and of well-established cost-estimating techniques tailored to research and development. Key to

the Program's approach is a strong emphasis on leveraging and partnering to cost-share risk and increase return on investment.

CURRENT STATUS

Quantitative measures of FY 1995 Program performance were as follows:

- Demonstrated a total of 109 improved technologies/systems.
- Made available for transfer to the private sector 21 technologies/systems.
- Directed 41 percent of the technology development budget to the private sector.

In addition, a number of EM Technology Development's industry partners have commercialized innovative environmental management technologies. A qualitative, yet tangible, mark of accomplishment is the receipt of six "R&D 100" awards from *R&D Magazine* for Technology Development funded technologies.

STRATEGIC ISSUES

- Obtaining technology verification and validation activities through timely and non-duplicative regulatory cooperation among states and federal agencies.
- Leveraging technology development by means of performance-based, cost-shared contracts and increased industry participation, utilizing performance measures that address regulatory criteria and health/environmental risks.
- Achieving individual user, regulatory, and stakeholder acceptance of innovative technologies and systems.
- Ensuring improved solutions are commercially available when they are needed by the sites.
- Maintaining a balanced portfolio of innovative technologies that are well aligned with users' actual needs, ranging from those building on the newest basic science advances to those approaching readiness for commercialization by industry, developed in a national program yielding near-term benefits while maintaining long-term vision and the ability to address the Department's cleanup problems.

Specific assumptions associated with resolving these strategic issues are:

- Barriers currently impeding the successful commercialization by industry of innovative environmental management technologies will be significantly reduced or eliminated.
- Standard regulatory criteria currently lacking will be established and serve as benchmarks for performance and acceptance of innovative technologies.

BUDGET AND LIFE-CYCLE COSTS

The budget for environmental management technology development is currently in the range of \$300 to \$400 million per year. (This sum pertains solely to applied research and technology development activities, and excludes transportation, infrastructure, risk, and science-related activities.) The budget is projected to remain at a level of approximately \$325 million per year for the remainder of the projected 20 year lifetime of the Technology Development Program, with a total program cost in the range of \$6 to \$7 billion.

Plumes Focus Area

Problem and Scope

The Plumes Focus Area is developing technologies to address environmental problems associated with certain priority contaminants found at many Department of Energy sites, including radionuclides, heavy metals, and dense, non-aqueous phase liquids (DNAPLs). Technologies for cleaning up contaminants common to the Department and other agencies, such as volatile organic compounds, polychlorinated biphenyls, and other organic and inorganic compounds, will be developed by leveraging resources through interagency programs and in cooperation with industry.

Technology Needs

The Plumes Focus Area will provide Environmental Management users effective methods to contain contaminant plumes and new/alternative technologies for remediating contaminated soils and ground water. Emphasis is placed on the development of in situ technologies to minimize waste disposal costs and potential worker exposure by treating plumes while still in the subsurface. Innovative technologies are needed in three major areas:

Site Assessment:

- Characterize complex hydrogeologic formations, such as fractured rock.
- Determine contaminant concentrations and migration patterns faster and cheaper.
- Detect mixed radioactive/hazardous plumes by non-invasive techniques.
- Detect and monitor dense, non-aqueous phase liquid (DNAPL) contaminants.
- On-line control sensors for in situ treatment processes.

Plume Containment:

- Predicting subsurface barrier performance to improve risk assessment.
- Reactive barriers and monitoring/maintenance systems that do not alter flow patterns.
- Barrier construction techniques that do not involve excavation.

Plume Remediation:

- Methods of altering contaminants to facilitate their removal, degradation, or destruction.
- In situ chemical methods (e.g., reagent injection) that allow reuse of fluids.

- Biological means and delivery systems to destroy DNAPLs and mixed contaminants.
- In situ methods for separating radionuclides from soil and water-dissolved waste streams.

The current program is designed to meet technical and schedule objectives by supporting ongoing activities of the Office of Environmental Restoration, including site characterization and assessment, near-term containment of contaminant plumes, and treatment of contaminants in aquifers and overlying soils. Many of the technologies needed for site assessment purposes are being developed in coordination with the Characterization Crosscutting Program. Likewise, containment technologies are being developed in conjunction with the Landfill Focus Area, since they fulfill similar technical needs in both focus areas.

Activities

The Plumes Focus Area has organized its technical work in three coordinated technology Product Lines to meet these needs as they relate to DOE's major plume problems: Dense, Non-Aqueous Phase Liquids, Metals and Radionuclides, and Organics. These Product Lines will emphasize and accomplish the following:

Dense, Non-Aqueous Phase Liquids: Pilot-scale demonstrations of systems for characterization and remediation of subsurface contaminant pools or liquid contaminants trapped in saturated and unsaturated fractured rock.

Metals and Radionuclides: Pilot- and full-scale tests of systems to characterize and remove or immobilize metals in aquifers and soils.

Organics: Completion or transfer of enhanced removal techniques, bioremediation for in situ destruction, and off-gas treatment.

How the Plumes Focus Area Will Meet Technology Needs

Within each Product Line, a number of technologies are currently in development to meet Environmental Management technology needs. To date, 21 site assessment technologies, 4 containment technologies, and 8 remediation technologies have been demonstrated, and 11 have been transferred or commercialized. Also, 10 demonstration facilities have been transferred to Environmental Restoration users for further use in site cleanup work. The following table lists major technologies that have been transferred or are ready for transfer, and their potential impact of the Product Lines:

Product Line/ Major Technologies	Site Assess- ment	Contain- ment	Remedia- tion	Product Line Impacts
<u>Dense, Non-Aqueous Phase Liquids:</u> <ul style="list-style-type: none"> • Surfactant/Alcohol flushing for DNAPL remediation • Characterization/Monitoring Technology for DNAPLs 	•		•	The new DNAPL Product Line provides characterization and remediation technologies to eliminate otherwise undetectable plume sources.
<u>Metals and Radionuclides:</u> <ul style="list-style-type: none"> • In Situ Redox Manipulation • Full Scale Reactive Barrier for Sr 90 • Tall Column Flotation • In situ chemical treatment 		•	• • • •	Provides innovative, more cost effective methods for containing and remediating soils in situ, rather than excavation, packaging and disposing at a storage facility.
<u>Organics:</u> <ul style="list-style-type: none"> • Resonant Sonic Drilling • Electrical Resistance Tomography • Envirowall Barrier • Portable Analyzer for Chlorinated Organic Compounds • Multisorbant Arrayed Sampler • Passive Soil Vapor Extraction • Unsaturated Flow Apparatus • Halosnif • In Situ Permeable Flow Sensor • PurCycle • In Well Vapor Stripping • Multi-Point Injection System • TEVES • Time Domain Reflectometry and Fiber-Optic Probes for Cone Penetrometer • Reactive Barrier Using Iron Fillings • PHOSter • Catalytic Oxidation System • High Energy Corona Off-Gas Treatment System • Flameless Thermal Oxidizer 	• • • • • • •	• • • •	• • • • • • • •	The Organics Product Line is complete and in project closeout phase; enables innovative characterization, containment, and remediation techniques for organic plumes, to augment technologies developed by other agencies and private industry. Technologies are usable at nearly all department sites.

Radioactive Tank Waste Remediation Focus Area

Problem and Scope

The Tank Waste Focus Area will provide technologies to safely and efficiently accomplish remediation of 332 underground storage tanks that have been used to process and store over 100 million gallons of radioactive and chemical mixed waste. Little of the waste has been treated and disposed of, many of the tanks have exceeded their life expectancies, and some tanks are leaking. The Tank Focus Area is concentrating on the problems at four locations: Hanford Site, Idaho National Engineering Laboratory, Oak Ridge Reservation, and Savannah River Site.

Technology Needs

Technologies are needed to characterize, retrieve, and pretreat the waste before radioactive components are immobilized, as well as to ensure a safe working environment in and around the tanks. Specific technology needs in four major areas have been identified by the Focus Area:

Characterization and Safety:

- In-situ and hot-cell chemical characterization of tank waste.
- Tank waste topographical mapping.
- On-line real-time analysis to support storage, pretreatment, and immobilization.
- Accurate moisture sensing.
- Detection and monitoring of tank leakage.

Waste Immobilization:

- Vitrification of spent ion exchange resins.
- Selection of waste form for immobilization of low-level waste.
- Consolidation of glass process controls development.

Waste Pretreatment:

- Solid/liquid separations to optimize pretreatment processes.
- Removal of radioactivity from the liquid waste.
- Volume reduction of solid waste (sludge) and liquid waste.

- Recovery and recycle of chemical components.

Waste Retrieval and Tank Closure:

- Improved waste dislodging, retrieval, and conveyance methods and tools.
- Deployment systems.
- Determination of tank closure criteria.

Activities

The Focus Area is organized into four program elements/product lines which are structured to meet the technology needs. Emphasis is placed on in situ or remotely handled processes and waste volume minimization. Some of the technologies are being developed in close coordination with the Crosscutting Programs (CPs) including the Efficient Separations and Processing and the Characterization, Monitoring and Sensor Technology. Objectives of each program element are:

Characterization and Safety: Develop remote waste characterization, topographic mapping, and leak detection systems, and associated robotics deployment systems.

Waste Immobilization: Demonstrate and gain acceptance for immobilization/vitrification techniques for cesium and low-level wastes.

Waste Pretreatment: Demonstrate cesium removal units, out of tank evaporators, and separation and treatment systems.

Waste Retrieval and Tank Closure: Develop robotic systems, as well as alternate technologies for waste retrieval, and demonstrate integrated closure system.

How the Tanks Focus Area Will Meet Technology Needs

Product Lines/Technologies	Technology Impacts
<u>Characterization/Safety:</u> <ul style="list-style-type: none"> • Remote Spectroscopy System • Light Duty Utility Arm System • Light Duty Utility Arm end effectors • Near Infrared Spectroscopy System • Laser Range Finder/Mapping System • Electrical Resistance Tomography • Cone Penetrometer System 	<ul style="list-style-type: none"> • Provides chemical characterization in situ or in hot cells • Enables deployment of robotics characterization systems in tanks • Measures waste properties in situ • Measures in situ water content • Maps tank waste surface topography • Detects leaks beneath and around tanks • Enables in situ investigation of solid waste

Product Lines/Technologies	Technology Impacts
<u>Waste Immobilization:</u> <ul style="list-style-type: none"> • Vitrification Process for Ion Exchange Resins • Low Level Waste Immobilization Process • Consolidated Glass Process Control 	<ul style="list-style-type: none"> • Provides the only acceptable disposal form • Will lead to acceptable waste forms • Integrates process controls across sites to reduce costs and risk
<u>Waste Pretreatment:</u> <ul style="list-style-type: none"> • Cesium Removal Unit • Out-of-Tank Evaporator • Advanced Sludge Treatment Method • Technetium Sorbents • Solid/Liquid Separation System • Sodium Hydroxide Recovery System 	<ul style="list-style-type: none"> • Minimizes high level waste volumes • Removes water to create additional tank storage space • Reduces solid waste volume • Reduce radioactivity of liquid waste streams • Will meet requirements at different sites • Enables recycling of process materials
<u>Waste Retrieval and Tank Closure:</u> <ul style="list-style-type: none"> • Enhanced Retrieval Tools and Systems • Commercial Light Duty Utility Arms • Full-Scale Closure Demonstration 	<ul style="list-style-type: none"> • Improve efficiency and safety • Retrieves heels and other difficult wastes • Provides key information for making closure decisions at all sites.

Facility Decontamination and Decommissioning Focus Area

Problem and Scope

The Facility Decontamination and Decommissioning Focus Area is developing technologies to solve the Department's problem of 7,000 contaminated buildings requiring deactivation and 700 contaminated buildings requiring decommissioning. In addition, over 550,000 metric tons of metal and 23 million cubic meters of concrete exist in contaminated buildings. Over 180,000 metric tons of metal currently in scrap piles require disposition. The major requirements for this Focus Area are the high safety and health risks associated with working in aged and contaminated facilities, and the high costs associated with facility deactivation, surveillance and maintenance using baseline technologies.

Technology Needs

Technologies are needed to characterize, deactivate, survey and maintain, decontaminate, dismantle, and dispose of surplus facilities and their contents. These needs are broadly grouped into the following areas:

Deactivation:

- Locating, sampling, and real-time characterizing of contaminants in piping and on concrete and metal surfaces.
- Techniques for separating radioactive contaminants in sludges, process liquids, and other media.
- Improving worker protection and improving efficiency under hazardous conditions.

Decontamination:

- Remote decontamination of metal and concrete surfaces, especially in inaccessible areas.
- Extraction of contaminants from structural concrete components and metal structures, components, and equipment.

Dismantlement and Disposition:

- Remote dismantlement and size reduction of structures and equipment.
- Recycling of metallic and non-metallic materials.
- Separation of lead and mercury from contaminated building materials.
- Reduction of disposition costs for contaminated structural components and equipment.

Activities

Technology development activities within the Focus Area center around large-scale demonstrations, each of which incorporates improved technologies identified as high-priority needs by the customers. Customers are also committed to considering all technologies for eventual deployment. This strategy provides side-by-side comparison of improved technologies with existing commercial (baseline) technologies. The Focus Area has organized its technical work according to the following structure:

Demonstrations and Industry Approach: Provide full-scale demonstrations of a suite of improved technologies alongside baseline technologies under real-world conditions as part of an actual ongoing decontamination project; implement deactivation and decontamination projects through industry solicitations such as a Program Research and Development Announcement.

Facility Deactivation: Provide enhanced removal methods for nuclear fuel, draining and/or de-energizing systems, and removal of stored radioactive and hazardous material to place facilities in a safe and stable condition.

Facility Decontamination: Emphasize innovative technologies for the removal of radioactive and/or hazardous contamination from facilities and equipment to achieve a stated end condition.

Facility Dismantlement and Material Disposition: Emphasize processes and technologies for (1) disassembly and/or demolition of facilities, components, and equipment for satisfactory interim or long term disposal, (2) destruction of associated toxic, radioactive, or other hazardous wastes, and (3) recycling or free release of materials as permitted.

How the Focus Area Will Meet Technology Needs

Product Lines/Technologies	Technology Impacts
<p><u>Facility Deactivation:</u></p> <ul style="list-style-type: none"> • Miniature Radiation Detector • Laser Induced Fluorescence Systems • Secondary Ion-Mass Spectrometer • Inductively Coupled Plasma Mass Spectrometer for Microliter Samples • Portable X-Ray, K-Edge Heavy Metal Detector • Advanced Worker Protection Systems • Pipe Explorer System • Coherent Laser Vision System • High Sensitivity Radionuclide Monitor • Interactive Remote Viewing System • Portable Hazardous Waste Sensor • Permselective Membrane/Carbon Adsorption Protective Clothing • Rapid Surface Sampling and Archive Record System • 3-D Integrated Characterization and Archiving System 	<ul style="list-style-type: none"> • Provides new means to immediately measure radioactivity • Detects radionuclides on surfaces • Detects radionuclides on surfaces • Improved speed, accuracy, and precision for detection of stable elements and radionuclides • Provides non-destructive assay of uranium and other heavy metals • Allows extended service time breathing and worker cooling • New technology for detecting contamination in pipes • Provides 3-D position and orientation • Provides greater sensitivity for radionuclide characterization • Reduces worker exposure • Provides on-site contaminant characterization • Improves worker safety • Provides immediate characterization of contamination • Provides rapid in situ analysis of contaminants
<p><u>Facility Decontamination:</u></p> <ul style="list-style-type: none"> • CORPEX Nuclear Decontamination Process • Gas Phase Decontamination Process • Recyclable Chelating Solvent Chemical Decontamination • Concrete Decontamination by Electro-Hydraulic Scabbling • Electrokinetic Decontamination of Concrete • Laser Ablation for Concrete and Metal Surfaces • Mobile Work System • Remote Vehicle Dry Ice Pellet System 	<ul style="list-style-type: none"> • Provides new decontamination method • New decontamination technology for gaseous diffusion facilities • Permits reuse of decontamination solvent • Removes contaminated surface layers more efficiently • New technology for removing contaminants from concrete surfaces • Innovative method for decontaminating metal and concrete surfaces • Enables remote/robotic D&D operations • Innovative system for concrete decontamination using carbon dioxide pellets

Product Lines/Technologies	Technology Impacts
<p><u>Facility Dismantlement/Material Disposition:</u></p> <ul style="list-style-type: none"> • Electromagnetic Mixed Waste Processing System for Asbestos • Asbestos Containing Material Conversion • Complexing Agents for Plutonium Removal • High Temperature Vacuum Distillation for Plutonium Waste Separation • Membrane Separation for Tritium • Water Soluble Polymers for Radionuclides • Advanced Decontamination/Conversion Technologies for Scrap Metal • Asbestos Pipe Insulation Removal System • Reconfigurable In-Tank Mobile Robot 	<ul style="list-style-type: none"> • Offers complete system for mixed/asbestos waste remediation • Reduces worker exposure by providing in situ abatement system for asbestos • New system to remove plutonium from wastewaters • Enables plutonium to be separated from high chloride salts and other transuranic wastes • Allows tritium removal from contaminated water • Will allow separation of plutonium and americium from waste waters • Provides treatment of contaminated nickel and potential beneficial recycling • Eliminates worker contact with asbestos pipe waste • Provides versatile worksystem for tank waste remediation

Mixed Waste Focus Area

Technology Needs

The Mixed Waste Focus Area provides an integrated, multi-organizational, national team to develop treatment systems for the Department's inventory of mixed radioactive/hazardous waste. New technologies are needed to treat an estimated 174,000 cubic meters of mixed waste (low-level and transuranic) in a regulatory acceptable manner. Technology needs occur in four major areas:

Characterization:

- Identification of radionuclide concentration in final waste form to ensure waste acceptance criteria are met.
- Develop nonintrusive methods that allow radiological, chemical, and physical characterization of whole, open containers.
- Development of support systems for treatment processes.

Treatment Systems:

- Increased treatment system efficiency, especially hazardous component destruction.
- Provide alternatives to thermal treatment that reduce final waste volume.
- Produce final waste forms that are acceptable for disposal.
- Minimize waste stream segregation and pretreatment requirements.

Effluent Systems:

- Improved effectiveness of off-gas treatment systems.
- Improved effluent containment, monitoring, and control systems.
- Avoidance of volatile metal and radionuclide release.

Final Waste Forms:

- Develop technology to ensure confinement of radionuclides and/or hazardous constituents in a durable, non-leachable matrix.
- Support treatment system development to ensure acceptable waste forms are produced.

Activities

The Mixed Waste Focus Area has organized its technical work in six coordinated Product Lines to meet these needs as they relate to DOE's major mixed waste types. These Product Lines will emphasize and accomplish the following:

Combustible Organics is a waste type which includes liquids and slurries containing >1% Total Organic Carbon (TOC) and solids which generate app. 20% (max.) residue (as ash) upon incineration. Slurries have Total Suspended Solids (TSS) of between 1% and 30%. Solids are defined as having >30% TSS (this includes sludges).

Homogeneous Solids/Soils waste streams contain at least 50% (volume) inorganic sludges, including water. Inorganic particulates, paints and salt wastes are included in this waste type. Sludges are generally considered to be unstable solids.

Solids/Debris/Soils is a waste type which includes those waste streams containing at least 50% (volume) debris which is defined as particle size greater than 60 mm and intended for disposal, or 50% soil, in which case silt, rock, and gravel less than 60 mm are included.

Treatment System Technologies are not waste types, but rather are technologies which support the primary treatment systems under development within the Focus Area. Emphasis is placed on characterization of waste feed materials and effluents, control of processing, and effluent capture.

Unique wastes are those generally low-volume streams such as lead shielding, other elemental heavy metals, batteries, fluorescent light bulbs, explosives and propellants, compressed gases, lab packs, etc., which are not included in the other waste types.

Waste Waters and Slurries are streams with <less than one percent total organic carbon and total suspended solids less than 30 percent.

How the Mixed Waste Focus Area Will Meet Technology Needs

Product Line/Technologies	Characterization	Treatment	Effluents	Final Forms	Impacts
<u>Combustible Organics:</u> <ul style="list-style-type: none"> Alternatives to incineration Cleanable steel HEPA filter Delphi DETOX Demonstration at Savannah River Low temperature thermal desorption Russian DeNOx catalyst Direct chemical oxidation 		<ul style="list-style-type: none"> • • • • 	<ul style="list-style-type: none"> • • • 	<ul style="list-style-type: none"> • 	Customer and stakeholder acceptance is enhanced through improved effluent quality and increased non-thermal treatment capacity. Destruction of RCRA components allows land disposal, which is currently not allowed.
<u>Homogeneous Solids (Sludges) & Soils:</u> <ul style="list-style-type: none"> Microwave vitrification Phosphate-bonded ceramics Polymer encapsulation Transportable vitrification system 		<ul style="list-style-type: none"> • • • • 		<ul style="list-style-type: none"> • • • • 	Multiple treatment approaches increase the number of waste streams treatable, increasing treatment capacity. These technologies improve performance, add treatment capacity, reduce risk, and minimize costs. (Impacts applies to both solids-related Product Lines)
<u>Solids/Debris/Soils:</u> <ul style="list-style-type: none"> Extractive Organic Pretreatment Front/back PHP support system Radioactive PHP pilot system Oak Ridge plasma processes Advanced process monitoring/control system Supercritical CO2 extraction process 	•	<ul style="list-style-type: none"> • • • • • 	•	<ul style="list-style-type: none"> • • 	
<u>Treatment System Technologies:</u> <ul style="list-style-type: none"> Controlled emission system Mercury vapor treatment system Advanced NDE/NDA system Real-time alpha monitor Continuous emission monitor for mercury vapor 	<ul style="list-style-type: none"> • • • 	•	<ul style="list-style-type: none"> • • • • 		Accurate, continuous, real-time measurement of gaseous effluent components allows improved process control and off-gas treatment. Remotely operated, non-intrusive waste characterization minimizes risk and costs associated with characterization of waste for treatment.
<u>Unique Wastes:</u> <ul style="list-style-type: none"> Robotic inspection systems Macroencapsulation technology Radioactive PCB system 	•	<ul style="list-style-type: none"> • • 	•		These technologies provide treatment capacity for waste streams which were untreatable by conventional technologies.
<u>Waste Waters/Slurries:</u> (Technologies to be determined, pending call for proposals)		•	•		Technologies are being identified which will increase performance, reduce risk, and minimize costs associated with treating these wastes.

Landfill Stabilization Focus Area

Problem and Scope

Landfills at Department of Energy facilities contain over three million cubic meters of buried waste, the majority of which is located at seven different sites. The waste is buried on pads or in trenches, sumps, ponds, pits, cribs, heaps and piles, auger holes, caissons, and sanitary landfills. Approximately half of the waste was disposed of before 1970, when regulations permitted commingling of hazardous and radioactive materials. As a result, much of the buried waste is presently believed to be contaminated with both hazardous and radioactive materials.

Most of the hazardous and radioactive buried waste is problematic because it may be a threat to the surrounding environment and the public. The Focus Area mission includes one-third of the sites identified with the highest risks by the Office of Environmental Restoration in April, 1994, and nearly half of the highest risk sites have potential correlated with the mission.

Technology Needs

The mission of the Landfill Stabilization Focus Area is to develop, demonstrate, implement, and deliver safer, more cost-effective and efficient technologies that satisfy end user needs for containment, remediation, and management of landfills. Technology needs addressed by the Focus Area are categorized into five major areas:

Assessment:

- Determine boundaries of landfill wastes.
- Identify and locate specific waste forms, such as drums, large metal objects, and voids.
- Characterize waste and determine constituent concentrations.
- Focus on non-intrusive technologies.

Retrieval:

- Remote operated equipment for retrieval of radioactive and/or mixed waste.
- Specialized dual-arm robotic techniques for hot spot retrieval.

Treatment:

- Pretreatment techniques to minimize waste.
- Primary treatment methods involving thermal, chemical, biological, and physical processes.

- Ancillary treatment systems associated with feed streams, process diagnostics, and secondary wastes.

Containment:

- Improved surface barriers or caps to prevent migration or leaching of contaminants.
- Vertical and horizontal barriers utilizing advanced materials.

Stabilization:

- Techniques to alter physical, chemical, and/or toxicological properties so as to achieve contaminant immobilization.

Activities

During FY 1996, technologies are being developed and/or demonstrated by the Focus Area in the following Product Lines, which coincide with the dominant contaminants and locations of landfills throughout the Department:

- Transuranic/Mixed Waste in Arid Soils
- Transuranic/Mixed Waste in Humid Soils
- Low Level and Other Wastes in Arid Soils
- Low Level and Other Wastes in Humid Soils

Technologies in these Product Lines will provide new or improved capabilities for landfill containment and in situ stabilization, non-intrusive characterization of sites and wastes, retrieval and treatment systems, verification and monitoring systems, and improved disposal systems. Current technology management procedures evaluate the market potential of technologies at a number of decision points throughout the development process. This ensures that as the technology matures, a customer is ready to implement or market it for use by the Department. An emphasis has been placed on technologies that reduce the cost of remediation. However, other benefits considered in the measures of success are reduction in the time required to complete remediation, reduction in waste generated during remediation, reduction in the potential for worker exposure, and providing a technical solution where no baseline or other acceptable technology is currently available.

How Landfill Stabilization Focus Area Will Meet Technology Needs

Product Line/Technologies	Assessment	Retrieval	Treatment	Containment	Stabilize	Impacts
<u>TRU/MIXED WASTE IN ARID SOILS</u> <ul style="list-style-type: none"> • Dig Face Characterization • In Situ Grouting Stabilization and Encapsulation • In Situ Waste Destruction and Vitrification • Stabilization of Buried TRU Tanks Using Grouting Techniques • Cooperative Telerobotic Retrieval (CTR) • Cryogenic Cutting Technology 	•	•	• •	• • •	•	
<u>TRU/MIXED WASTE IN HUMID SOILS</u> <ul style="list-style-type: none"> • Semiconductor Detectors for TRU Waste Assay • Secondary Offgas Treatment • Graphite DC Arc Plasma System • Hybrid Plasma/Induction Melter 	•		• • •			
<u>LLW/OTHER WASTES IN ARID SOILS</u> <ul style="list-style-type: none"> • Alternative Landfill Covers • Subsurface Barrier Emplacement • Capillary Barrier Design Tools • Smart Geomembrane • Tracers for Verification/Monitoring of Containment 	• •	• • • •				

<u>LLW/OTHER WASTES IN HUMID SOILS</u>						
• Radon Monitoring and Removal System	•	•				
• Biomass Remediation			•			
• Wet Chemical Oxidation of Contaminated Organics			•			
• Slurry Carbonization of Organic Wastes			•			
• Emerging Continuous Emissions Monitoring Technologies	•					
• Perfluorocarbon Tracer Verification of Barrier Integrity	•			•		
• Cryocell Barrier			•			
• Viscous Liquid Barriers			•			
• Surface Containment Systems Repair			•			
• In Situ Intrinsic Bioremediation of Landfills		•				
• Chemically Reactive Backfills		•				
• Closure of HLW Tanks using Stabilized		•				
• Contaminated Soil and Debris System		•				